IMPROVED ROAD REPAIR SYSTEMS

The present invention relates to asphalt repair systems and in particular to systems useful in the repair of roads.

Asphalt deteriorates because of oxidation and the constant pounding of traffic, but it is the joints from old repairs that become the Achilles heel as weather and water ingress and break up the seal and adjacent asphalt. Considerable sums of money are spent each year on routine maintenance and repair of carriages and footways, and the utility companies also spend large sums making effective repairs after their excavations. Furthermore, roads are generally deteriorating.

Bituminous wearing courses such as asphalt are generally composed of about 94% aggregate (gravel or sand) and about 6% bitumen binder. The bitumen binder is composed of hydrocarbons and has ionic properties, which serve to bind the sand and gravel particles together.

Wearing courses deteriorate through oxidation of the bituminous binder. The oxidation process reduces the ionic properties of the bitumen, which in turn leads to release of the aggregate. The oxidised binder loses its flexibility and the surface shrinks and cracks. The effects of traffic and weather (temperature changes and moisture) speed up this process. After general release of material larger flaws appear which eventually turn into potholes.

The oxidisation process accelerates other damage to the wearing course and failure of joints especially from conventional reinstatements, around ironwork and on trenchwork.

The traditional method for the repair of damaged or aged asphalt and tarmacadam-wearing courses comprises the total removal of an area and its replacement with new asphalt. The damaged area and its surrounds may be removed by using noisy pneumatic or hydraulic hand held or machine mounted breakers. In this traditional method it is necessary to use expensive and very noisy diamond saws to pre-cut the area to minimise additional damage and to form a face to bond in the replacement material. The areas may also be removed by more modern methods known as cold planing that pulverizes the damaged asphalt.

The area is then filled with new material that then needs to be compacted and sealed with overbanding or jointing sealant. The removed asphalt is then transported away for disposal that is normally for land–fill due to the limitations of current re-cycling systems.

These conventional methods are not ideal in respect of costs, safety, environment, sustainability and durability. Such methods are described in United States Patent 4534674 and German Patent application 3906352 A1.

More recently Hot In-Place Recycling (HIR) techniques have been developed for the effective repair of potholes, cracks and sunken utility cuts in asphalt surfaces using an infrared heating process. With the surface heated and raked it is then combined with a rejuvenation liquid that will recycle the existing embrittled asphalt. This enables a substantial reduction in repair costs. A typical rejuvenating liquid for use in the method generally comprises maltenes. Preferred liquids contain an emulsifier, a heavy paraffinic distillate solvent extract, a heavy naphthenic distillate solvent extract and water and is described in WO00/20689 optionally with other additives.

The Infrared HIR method comprises: heating the damaged area with an infrared heating device; adding new material if required; raking together; applying a liquid that rejuvenates the original bitumen; and compacting the new combined material.

The HIR method can also include applying a topcoating liquid to the repaired area that seals and binds the repair, or applying a fine aggregate to provide skid resistance.

The present invention provides improved equipment for performing the Infrared HIR techniques described above, comprising a single vehicle road repair system with means for supplying infrared heat to the surface to be repaired, means for storing and supplying hot new asphalt, means for storing and supplying a rejuvenation liquid, and means for storage and supply of gas for heating.

In a first embodiment the vehicle may be a truck, fitted at the rear with an infrared heater system that is adapted to be moved towards and away from the surface to be repaired. The flatbed would have fitted a hot box that contains replacement asphalt if required, an adjacent tank containing rejuvenation liquid which may use the hotbox residual heat to maintain a good working temperature, and preferably a pump and lance for delivery of the liquid to the desired location. In a preferred embodiment a small waste container may be provided. A secure area is preferably provided for hand tools and other equipment such as traffic control signs, rakes and equipment. A tow bar may be fitted for towing a trailer-mounted compaction roller.

In a preferred embodiment the infrared heating system is hinged so that it may be folded up against the back of the truck when not in use. It is further preferred that the heater be fitted with a cover to protect the otherwise exposed heating surface.

Advantages over an existing vehicle such as the vehicles manufactured by Ray-Tech Infrared Corp., as shown on their web site, are:

1. Built in tank, pump and delivery system, such as a spray lance for storage and application of rejuvenation liquid.
2. A tow bar for a trailer-mounted compaction roller and a built in gas tank so avoiding the need for a hydraulic lifting arm to load and unload the roller and large gas bottles.
3. A secure enclosed area, for loose tools and equipment, typically secured by a lockable sliding curtain securing the front half of the vehicle's flatbed.

In a further preferment the heater blanket is made of Fecralloy® which heats quickly and cools to ambient in less than 5 seconds, providing significant safety advantages. The blanket, whether of Fecralloy® or another suitable material may be heated using LPG supplied through a vaporiser system.

In another embodiment the vehicle may be a tractor backhoe or wheeled or skid-steer loader to which the equipment may be quickly installed or removed. The attachment that forms the infrared heater being fixed to the dipper arm (of a backhoe loader) or the front loader quick change system (of a skid steer) so that it may be moved towards and away from the surface to be repaired. This attachment can also contain the associated gas bottles and control systems. These control systems are preferably such that they enable independent on/off control of each burner within the heater. A separate attachment may be fitted to the rear of the vehicle containing a hot box for new asphalt, an adjoining tank for rejuvenation liquid that uses the hotbox residual heat to maintain a good working temperature, and a spray lance for its application to the raked area. With this system the area to be repaired may be heated with the vehicle which is then moved quickly away to a suitable position, the heated area is then raked so that the rejuvenating liquid may be delivered to the prepared surface of the area being repaired, prior to compaction.

Such attachments for tractor backhoe vehicles are a part of the present invention.

The advantages of this invention when used in a skid-steer solution over existing skid-steer attachments manufactured by Ray-Tech Infrared Corp. are:

1. Built in tank, pump and spray lance for storage and controlled application of warm rejuvenation liquid.
2. Built in hotbox to enable independence from a separate supply of hot asphalt when operating.
3. In a preferred system the heater incorporates a more robust heater blanket of Fecralloy® which heats quickly and cools to ambient in less than 5 seconds. This provides significant safety advantages.

The invention therefore provides more efficient, compact and lightweight equipment that enables faster, quieter and more economic method of repair of a wearing course using Infrared HIR techniques.

The heating of the damaged area to be repaired may be carried out using one or more LPG powered infrared heaters depending on the size and shape of the area to be repaired. The heating needs may be to depths of 10 mm to 100 mm from the surface. The average temperature of the heated material should generally not exceed 200°C and may be from 50 to 200°C, preferably 100 to 200°C. As with all carbon structures heat increases oxidation, but since the infrared output of the infrared attachment is selective at its medium wave output it does not induce burning (which would destroy the binder's asphaltenes permanently). The heating time may vary according to its structure and dependant upon the surface temperature, wind chill factor and whether the surface is damp, but may for example be from 5 to 20 minutes, typically 6 to 8 minutes.

Once heated, the damaged area is raked or scarified to mix the highly oxidised top surface with the less oxidised sub-strata. This also increases the surface area of the mix. Care must be taken to leave an outer perimeter of the heated area unraked to allow development of an efficient bonded joint when compacted.

The rejuvenating liquid may then be applied using the lance provided. The composition of the rejuvenating liquid comprises rejuvenating oils high in aromatics with high levels of polar compounds. The oils in the rejuvenating liquid are preferably emulsified with cationic slow set emulsifiers at higher than normal levels to ensure not only a very storable and stable emulsion but also to aid in a slow cure and break time.

The rejuvenating liquid preferably contains from 30 to 80 parts by weight in total of a heavy paraffin distillation solvent extract and a heavy naphthenic distillate solvent extract, from 10 to 60 parts by weight of water, and from 1 to 5 parts by weight of the emulsifier. More

preferably, the liquid comprises from 60 to 65 parts by weight in total of the heavy paraffinic distillate solvent extract and the heavy naphthenic distillate solvent extract, from 30 to 35 parts by weight of water and from 1 to 5 parts by weight of the emulsifier.

New material may be needed if it is required to level the patch to be repaired, i.e., the amount of material that has been worn out of the surface. The material may also assist in knitting of the joint. On hot rolled asphalt, precoated chippings are added and compacted into the surface to give road texture. The material is generally raked level and then compacted either by a vibrating roller or compaction plate. A topcoat of a sealer/binder may also be applied, or a dusting of fine aggregate (e.g. aluminium silicate) may be added to ensure good initial skid resistance. Once the surface has cooled and hardened, normally for a minimum of one hour, it is capable of accepting traffic.

The advantages to using the apparatus of the present invention over traditional methods are:

1. Reduced asphalt costs since only material lost as a result of the damage is added: in the conventional method it is also necessary to replace material that is removed from around and beneath the damaged area. Substantial cost savings arise due to avoiding the need to transport the removed asphalt to land fill with its additional charges.

2. The resulting repair is fully bonded with the existing material by means of heat fusion. This eliminates or reduces the problems of joint failures and the problem of 'cold shock' that occurs in the conventional method when hot sealant or new material is added to cold asphalt to join the new material to the old material. There is no pre-cutting of an edge to the old surface, no need for any kind of overbanding or joint sealing (notoriously short-lived), and no mixing of materials with different expansion and contraction rates next to each other. Furthermore, when the application of the topcoating is included in the method of the invention, the surface is further bonded.

3. By recycling the existing surface there is far less new material used, the process is very quiet, and its speed enables the roads to be opened up far more quickly than would normally be the case. Due to the lack of noise, roads may be repaired at night while traffic is at its lightest with less disturbance to residents.

4. This method of repair also eliminates the problems of 'white finger' caused by pneumatic and hydraulic hand held breakers, which is a major problem to the construction industry, causing added costs to all concerned.

5. Some 94% of the wearing course is rock or sand and has an extremely long lifetime of many decades. Of the 6% of the wearing course that is binder, only a small fraction is degraded and the remainder (the predominant compounds being asphaltenes) has a very long life span. By replacing only the fraction of the aromatic oil component that is lost, the total combined method of the invention is highly efficient in material terms, and as a result effectively recreates the hydrocarbon chain.

The invention is illustrated by reference to the accompanying drawings in which:

Figure 1 shows an apparatus consisting of a vehicle 1 to which is attached a hot box 2 at the front of the vehicle and at the back there is a dipper arm to which is attached a bank of infrared heaters 3 in a manner that may be moved up and down towards the road surface to heat the areas to be repaired.

Figure 2 shows the composition of the hot box used in Figure 1 showing compartments 4 and 5 for the rejuvenating liquid and a pipe 6, connected at one end to a pump 7 and at the other end to a lance 8 to provide the delivery system for the rejuvenating liquid.

Figure 3 shows the attachment to the dipper arm 9 of the vehicle of Figure 1 on which are mounted the infrared heaters 10. The attachment is also provided with an ON/OFF Sensor 11 so that the heating can be controlled by the proximity to the road surface.

Figure 4 shows a truck 12 according to the present invention provided at the back with a bank of infrared heaters 13 which are hinged so that they can be stored against the back of the truck when not in use as shown in Figure 4. The truck is also provided with hot box and compartment 14 for the rejuvenating liquid and a pump 15, pipe 16 and lance 17 for delivery of the liquid. The truck may also be provided with other compartments for example those shown at 18 and 19 for the storage of other useful equipment.

Figure 5 is a plan view of the truck of Figure 4 showing the bank of infrared heaters moved downwards to be parallel to the road in their operating mode.

Figure 6 is a plan view of a preferred burner system which may be used with the apparatus shown in Figures 1 to 3. Figure 6 shows two pairs of burners 20 and 21 mounted in an angle frame which is preferably of steel. Four gas bottles 22 to 25 are located within the assembly and the complete assembly is suspended from a central column 26.

Figure 7 is a side view showing how the gas bottles may be mounted and held securely within the supporting frame 27 by stirrups 28 and 29 which may conveniently be of the type used for cargo restraint.

Figure 8 shows how doors 30 and 31 may be provided (shown in the open position in Figure 8) for safety and security purposes. Figure 8 also shows in more detail the central column which may be used to suspend the heater assembly including a spherical plain thrust bearing 32 which is tensioned with a compression spring 33 which can act as a shock absorber.

In the operation of both systems illustrated, the damaged area to be repaired is heated by the infrared system attached to the vehicle, after which the area is then raked. The pump may then be activated to deliver the rejuvenating liquid. The mix of heated original asphalt plus new material if required may then be further raked before being compacted by a vibrating roller or compaction plate. Once leveled to the original surface profile it is ready to accept traffic.